

## SECTION 03 3001

### REINFORCED CONCRETE

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#### LANL MASTER SPECIFICATION

This section applies to structural concrete for buildings that are designed in accordance with ACI 318, facilities classified as Natural Phenomena Hazards Performance Category (PC) 1 or 2 facilities, and ML-3 and ML-4 projects. In general, this section does not apply to nuclear facilities. This section may apply to nuclear facilities that, because of the amount of material at risk, are classified as PC-2.

For Nuclear facilities, ML-1 / ML-2 projects, and PC 3 and 4 this specification must be further amplified and developed. This would include considering design requirements from DOE STD-1020, ACI 349 as well as ACI 318, and "Quality Assurance Requirements" from 10 CFR 830.120-122 and 830.200-203, "Safety Basis Requirements." Also, use additional quality assurance requirements from DOE G 414.1-1A as applicable. Independent review would also be required.

When editing to suit project, author shall add job-specific requirements and delete only those portions that in no way apply to the activity (e.g., a component that does not apply). Note: Items in brackets are to be added or omitted according to job specific requirements. To seek a variance from applicable requirements, contact the Engineering Standards Manual (ESM) Structural POC.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Delete information within "stars" during editing.

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#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Formwork, shoring, bracing, and anchorage.
- B. Concrete reinforcing and accessories.
- C. Cast-in-place concrete.
- D. Control, expansion, and contraction joint devices associated with concrete work.

##### 1.2 DEFINITIONS

- A. "Cementitious material" as used herein shall include all Portland cement, pozzolan, fly ash, [ground iron blast-furnace slag, and silica fume].
- B. Reinforced concrete is structural concrete reinforced with no less than the minimum amounts of prestressing steel or nonprestressed reinforcement specified in ACI 318 Chapters 1 through 21 and Appendices A through C.

- C. Plain concrete is structural concrete with no reinforcement or with less reinforcement than the minimum amount specified for reinforced concrete. Specifications for plain concrete are presented in section 03 3053, "Concrete Sidewalks, curbs and gutters, and miscellaneous".

### 1.3 REFERENCES

- A. As noted in these specifications form a part of these specifications to the extent referenced. The publications are referred to in the text by the basic designation only. The related publishing organizations are stipulated in Section 01 4219 of these specifications ("Referenced Standards").
- B. All concrete work, products and materials conform to ACI 301 and other specific referenced publications and standards except where otherwise specified herein.

### 1.4 SUBMITTALS

- A. Submit the following in accordance with Section 01 3300, Submittal Procedures:
- B. Concrete design mixes.

- 1. Mix design submittals:

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete to the Contracting Officer for approval. A complete list of materials including type; brand; source and amount of cement, fly ash, pozzolans, [silica fume], ground slag, and admixtures; and applicable reference specifications shall be included in the mix design submittal. Note that the use of fly ash may require an increase of air entraining admixture to maintain air content of concrete within specified levels. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required. If source material changes, resubmit mix proportion data using revised source material. No material shall be provided unless proven by trial mix studies to meet the requirements of this specification, and approved in writing by the Contracting Officer. The submittal shall clearly indicate where each mix design will be used when more than one mix design is submitted. Submit additional data regarding concrete aggregates if the source of aggregate changes. In addition, copies of the fly ash, [silica fume], and pozzolan test results shall be submitted. The approval of fly ash, [silica fume], and pozzolan test results shall have been within 6 months of submittal date. Obtain acknowledgement of receipt prior to concrete placement. Note, design mixes intended to provide more flexibility than the stated ranges [slump, air content, water cement ratio, etc.] must obtain a formal variance to the specification.

- a. Submit separate mix design for:
  - i. Each concrete strength.

- ii. Each range of air content.
  - iii. Each nominal maximum aggregate size.
  - iv. Concrete to be pumped.
  - v. Concrete with identifiable admixtures.
- b. Include the following information with each design:
  - i. Quantity of water.
  - ii. Type, brand, certification, and quantity of cement.
  - iii. Source, certification, and quantity of each nominal maximum size of aggregate.
  - iv. Type, brand, sources, certification and quantity of admixture, if used.
  - v. Type, source, certification and quantity of fly ash.
  - vi. Water/cement ratio.
  - vii. Air-content.
  - viii. Slump
  - ix. Aggregate-correction factor to meet ASTM C-231
- c. Test Reports for each design:
  - i. Concrete mix tests including strength in accordance with ACI 301, ASR resistance for mix (in accordance with ASTM C 1260 or AASHTO T 303-00), air content, weight and yield (ASTM C 138).
  - ii. Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix will be suitable for the job conditions. The laboratory test reports shall include mill test and all other test for cement, fly ash [slag], [silica fume], aggregates, and admixtures. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Test reports shall be submitted along with the concrete mix design. Obtain approval from Contracting Officer before concrete placement.
  - iii. Fly ash and other pozzolans: ASTM C 618.
  - iv. Ground blast furnace slag, where used, ASTM C 989.

- v. Aggregates, petrographic analysis, ASTM C 295 and potential ASR use ASTM C 1260 (with no additives such as fly ash) or one of several other ASTM tests for ASR (ASTM C 227, ASTM C 289, ASTM C 1293).

### C. Batch Tickets

1. Submit 2 legible copies of the batch ticket for each load of concrete to the LANL Construction Inspector.
2. Conform to the requirements for batch tickets in accordance with ASTM C 94. Include the following information:
  - a. Name of ready-mix batch plant.
  - b. Serial number of ticket.
  - c. Date.
  - d. Truck number.
  - e. Name of purchaser.
  - f. Specific designation of job (name and location).
  - g. Specific class or designation (pre-approved design mix number) of the concrete in conformance with that employed in job specifications.
  - h. Amount of concrete in cubic yards (or cubic meters).
  - i. Time loaded or of first mixing of cement and aggregates.
  - j. Water added by receiver of concrete and his initials.
  - k. Reading of revolution counter at the first addition of water.
  - l. Type and brand, and amount of cement.
  - m. Type and brand, and amount of admixtures.
  - n. Class, brand, and amount of coal fly ash, raw or calcined natural pozzolans [grade, brand and amount of ground granulated blast-furnace slag].
  - o. Information necessary to calculate the total mixing water added by the producer. Total mixing water includes free water on the aggregates, water, and ice batched at the plant, and water added by the truck operator from the mixer tank.

- p. Maximum size of aggregate.
  - q. Weights of fine and coarse aggregate.
  - r. Ingredients certified as being previously approved.
  - s. Signature or initials of ready-mix representative.
- 3. Record on each, the location where placed in structure and time of placement.
- D. Formwork calculations and drawings:
  - 1. Provide design calculations as appropriate per ACI 347R indicating arrangement of forms, sizes and grades of supports (lumber), panels, and related components. Design forms for full liquid static head of concrete. Furnish drawings and calculations of shoring and re-shoring methods proposed for floor and roof slabs, spandrel beams, and other horizontal concrete members, prepared by or under supervision of a qualified professional engineer. Provide formwork drawings showing details of formwork including; joints, supports, studding and shoring, and sequence of form and shoring removal, prepared by or under supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
- E. Shop Drawings: Indicate bar sizes, spacing, locations and quantities of reinforcing steel and welded wire fabric, bending and cutting schedules, supporting and spacing devices.
- F. Provide certified copies of mill test reports for reinforcing material. Comply with the provisions of ASTM A-615 section 20 for mill certificate tagging of reinforcing material.
- G. Product Data: Provide data on joint devices (sealer and filler), attachment accessories, admixtures, materials for coring concrete, vapor retarder and barriers, [epoxy bonding compound], waterstops.
- H. Test reports of concrete field testing per Section 3.10, Field Quality Control.
- I. Testing agency and personnel certifications.
- J. Pre-Approved Concrete Mix Design Verification: As stipulated in Section 2.7 H, submit source documentation and component analyses to verify compliance of concrete batch materials to the pre-approved mix design. The laboratory test reports shall include mill test and all other test for cement, fly ash [slag], [silica fume], aggregates, and admixtures. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size.

## 1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301, 318, and 347, ACI SP-66, CRSI 63, 65 and Manual of Practice, ANSI/ASTM A184 and DOE Order 414.1B.
- B. The Contractor shall develop and maintain a Quality Assurance Program/System that complies with the requirements of LANL LPR-308-00-00, QA, for the project in accordance with ACI 121R. The Contractor shall obtain a current uncontrolled copy of the supplier's Quality Assurance Plan/Manual for the Contractor's QA Department's review and approval. All subsequent revisions, for the duration of the job, shall also be received for approval. The Contractor shall submit both his Assurance Program /System and the supplier's QA Plan/Manual for LANL review.
- C. The work shall be subject to inspection at all times by the Owner and Owner's Independent Testing Agency for the purpose of determining that the work is properly executed in accordance with this specification. Failure to detect defective workmanship or material during any interim inspection shall not constitute acceptance or workmanship and materials.
- D. Acquire cement from same source for all work, except as provided under Section 1.4.B.1.
- E. Acquire aggregate from same source for all work, except as provided under Section 1.4.B.1.
- F. Acquire fly ash from same source for all work, except as provided under Section 1.4.B.1.
- G. Conform to ACI 305R when concreting during hot weather.
- H. Conform to ACI 306R when concreting during cold weather.
- I. Testing Agency Qualifications: Testing agencies that perform concrete related testing shall be nationally accredited in accordance with ASTM C-1077 and testing agencies that perform reinforcing steel testing shall meet ASTM E-329. For field and laboratory testing agencies and testing personnel, submit current certifications for approval by the LANL Building Official, or designee, in accordance with the provisions of the IBC.

## 1.6 DELIVERY, STORAGE AND HANDLING

- A. Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Job site storage of materials shall be in accordance with ACI 301. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed.

- B. Inspection/Documentation Verification Hold Point: Product and raw material inspection shall be performed at time of delivery to site receiving area and prior to off-loading and incorporation into the work. Verify conformance with specified requirements and project environmental, safety and health (ES&H) and radiological requirements through inspection of material, shipping documentation, material safety data sheets (MSDS) documentation, data sheets, test documentation and other shipping manifest information. Material not passing inspection shall be marked and prevented from entering the site or placed in an off-site quarantine area until the inspection and verification process is satisfactorily completed.
- 1. Reinforcement: Store reinforcement of different sizes and shapes in separate piles on racks raised above the ground (to avoid excessive rusting). Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

## PART 2 PRODUCTS AND MATERIALS

### 2.1 GENERAL

- A. All concrete work, projects and materials shall conform to applicable provisions of ACI 301 except as otherwise specified herein.

### 2.2 FORM MATERIALS AND ACCESSORIES

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints
  - 1. Plywood, metal, or other approved panel materials.
    - a. Metal form surfaces shall not contain irregularities, dents, or sags.
    - b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
      - i. High-density overlay, Class 1 or better.
      - ii. Medium density overlay, Class 1 or better; mill-release agent treated and edge sealed.
      - iii. Structural 1, B-B or better; mill oiled and edge sealed.
      - iv. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
    - c. AHA A135.4, hardboard for smooth form lining.

2. Prefabricated forms.
- a. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
  - b. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.
  - c. Pan Type: Glass fiber of size and profile required.
  - d. Tubular Column Type: Round, spirally wound laminated fiber material, surface treated with release agent, non-reusable, of sizes required.
  - e. Void Forms: Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete mix until initial set; 2 inch thick.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Form Ties: Snap off type, galvanized metal cone type with waterproofing washer free of defects that could leave holes larger than 1 in. in concrete surface.
- D. Form Release Agent: Colorless mineral oil which will not stain concrete, absorb moisture, or impair natural bonding or color characteristics of coating intended for use on concrete.
- E. Corners: Chamfered, wood strip type;  $\frac{3}{4}$  x  $\frac{3}{4}$  in. size.
- F. Dovetail Anchor Slot: Galvanized steel, 22 gage thick, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- G. Flashing Reglets: Galvanized steel, 22 gage thick, longest possible lengths, with alignment splines for joints, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- H. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Size as required, of sufficient strength and character to maintain formwork in place while placing concrete.
- I. Waterstops: Polyvinyl chloride, minimum 1750 psi tensile strength, minimum 50 degrees F to plus 175 degrees F working temperature range, maximum possible lengths, ribbed profile, preformed corner sections.



## 2.3 REINFORCING AND ACCESSORIES

- A. Reinforcing Steel: ASTM A 615, grade 60 deformed bars and stirrups; ties grade 40. Reinforcing steel resisting earthquake-induced flexural and axial forces in frame members and in structural wall boundary elements shall comply with ASTM A 706. ASTM A 615 Grades 40 and 60 shall be permitted in these members if the actual yield strength of the reinforcing steel meets the strength requirements in ACI 318, Section 21.2.5.
- B. Welded Steel Wire Fabric: ASTM A 185 Plain type in flat sheets.
- C. Fabricate concrete reinforcing in accordance with CRSI Manual of Practice.
- D. Locate reinforcing splices not indicated on Drawings at points of minimum stress.
- E. Welding of reinforcing bars will be permitted only with approval of the Contracting Officer. Welding, if approved, shall conform to ACI 301 Section 5.4 and AWS D.1.4 and shall meet the requirements of LANL ESM, Chapter 13, Welding. Reinforcing steel cannot be used for filler metal, gap filler, or other uses that involve welding.
- F. Chairs, Bolsters, Bar Supports, Spacers: Size and shape for strength and support of reinforcement during concrete placement conditions including load bearing pad on bottom to prevent vapor barrier puncture. Special chairs, bolsters, bar supports, spacers adjacent to weather exposed concrete surfaces to be plastic coated steel type; size and shape as required.
- G. Tie Wire: Minimum 16 gage annealed type.

## 2.4 CONCRETE MATERIALS

- A. Cement: ASTM C 150, Type I or Type II.
- B. Fine and Coarse Aggregates: Conform to ASTM C 33.
- C. Water: Potable water that is clean and not detrimental to concrete.
- D. Fly Ash: Conform to ASTM C 618, type F. Fly ash, 20% to 30% of combined weight of fly ash and cement shall be used for the LANL standard concrete mix. For alternate acceptable means of reducing ASR, see Part 1, Section 1.4.B.1 of this specification.

## 2.5 ADMIXTURES

- A. Air Entrainment: Conform to ASTM C260.
- B. Chemical: Conform to ASTM C494.

## 2.6 ACCESSORIES

- A. Bonding Agent: Polymer resin emulsion.
- B. Vapor Barrier: 6 mil clear polyethylene film of type recommended for below grade application.
- C. Non-Shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2400 psi in 48 hours and 7000 psi in 28 days.
- D. Joint Filler: ASTM D 1751; asphalt impregnated fiberboard or felt, 1/4 in. thick.

## 2.7 CONCRETE MIX

### A. STANDARD MIX DESIGN

1. The standard mix design for LANL shall contain from 20% to 30% by weight of total cementitious material Type F fly ash conforming to ASTM C 618 for mitigating the deleterious effects of alkali-silica reaction in concrete that is common with the silicious nature of aggregates found in northern New Mexico. Pre-approved mix designs shown in 2.7.H may be used as long as the materials and their properties remain constant.

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Note: Alkali silica reaction is the reaction between the alkali hydroxide in Portland cement and certain silicious rocks and minerals present in the aggregates, such as opal, chert, chalcedony, trydymite, cristobalite, strained quartz, etc. The products of this reaction often result in significant expansion and cracking of the concrete, and ultimately failure of the concrete structure, including significant potential for foreign object damage.

EPA recommends that procuring agencies use concrete and other cementitious materials containing coal fly ash (pozzolan). Include the limits on soluble alkalies for Portland cement and for pozzolan whenever there is a possibility of alkali-aggregate reactive aggregates being furnished.

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### B. ALTERNATE MIX DESIGNS

Alternate means for mitigating alkali-silica reaction, including use of ground slag, silica fume, or lithium compound admixtures will be acceptable if appropriate tests and documentation are submitted in advance to the Contracting Officer and approved. Note: Mix designs intended to provide more flexibility than the ranges [slump, air-content, water cement ratio, etc.] must obtain a formal variance to the specification.

1. Where aggregates are provided which are demonstrated through appropriate tests to have acceptable ASR levels (less than 0.1%), mix designs may be provided without the fly ash or other ingredients as noted in section 2.7.B.1, above. Tests required are ASTM C1260 or AASHTO T 303-00 (or other pre-approved alternate).

2. Mix, test, and deliver concrete, along with test records in accordance with ASTM C 94. Mixing water must be added with the use of a calibrated measuring device, such as a mechanical water meter. Tank sight glasses are not acceptable.
3. Demonstrate acceptable ASR resistance for concrete with fly ash using ASTM C 1260 or AASHTO T 303-00. Also see Part 1, Section 1.4.B.1 of this specification.
4. Select proportions for normal weight concrete in accordance with ACI 301, proportioning on the basis of previous field experience or trial mixtures method, for

$f_{cr}$  = the larger of:

$$f_{cr} \geq f'_c + 1.34s, \text{ or}$$

$$f_{cr} \geq f'_c + 2.33s - 500, \text{ where:}$$

$f_{cr}$  = required average compressive strength of concrete mix design, psi

$f'_c$  = specified design compressive strength of concrete, psi

s = standard deviation, psi

If a suitable record of tests is not available to establish a standard deviation, use the following:

$$f_{cr} \geq f'_c + n, \text{ where:}$$

n = additional required strength, psi, for a specified  $f'_c$ :

n = 1000 psi for  $f'_c$  = less than 3000 psi.

n = 1200 psi for  $f'_c$  = 3000 to 5000 psi.

n = 1400 psi for  $f'_c$  = over 5000 psi.

5. Concrete Mix Designs shall be original work performed by the supplier's testing agency. Mix designs extrapolated from pre-selected data are not permitted. Configuration mix designs -- i.e., those already in use by the supplier -- are also not permitted, except for those shown in 2.7.H. All mix designs will be established through the process of trial batch determination of the compressive strengths at the various water-cement ratio trial points for each concrete class, and shall adhere to the requirements of this section.
6. Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified shall be the responsibility of the Contractor. Mixture proportions shall be based on compressive strength (as noted above) as determined by test specimens fabricated in accordance with ASTM C 192 and tested in accordance with ASTM C 39. Samples of all materials used in mixture proportioning studies

shall be representative of those proposed for use in the project and shall be accompanied by the manufacturer's or producer's test report indicating compliance with these specifications. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.1. Note that the use of fly ash may require an increase of air entraining admixture to attain specified air content of concrete. The trial mixture shall use at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratio required will be based on equivalent water-cement ratio calculations as determined by the conversion from the weight ratio of water to cement plus pozzolan, [silica fume,] and ground granulated blast-furnace slag by weight equivalency method. Laboratory trial mixture shall be designed for maximum permitted slump and air content. Each combination of materials proposed for use shall have a separate trial mixture, except accelerators or retarders can be used without separate trial mixtures. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192 and tested in accordance with ASTM C 39 for 7 and 28 days. From these results, a curve shall be plotted showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition a curve shall be plotted showing the relationship between 7 and 28 day strengths.

C. Provide concrete meeting the following criteria:

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The Structural Engineer shall specify the required 28 day concrete strength,  $f'_c$ , in accordance with the Structural Standards.  
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1. Exterior concrete exposed to freezing and thawing.
  - a. Compressive strength,  $f'_c$ : [4,000 psi @ 28 days].
  - b. Maximum nominal aggregate size: [0.75 in.]
  - c. Maximum water / cement ratio: [0.44].
  - d. Slump: [4 inch maximum].
  - e. Air content: [4 to 6] percent.
2. Exterior concrete to be pumped, exposed to freezing and thawing.
  - a. Compressive strength,  $f'_c$ : [4,000 psi @ 28 days].
  - b. Maximum nominal aggregate size: [0.75 in.]
  - c. Maximum water / cement ratio: [0.38].

- d. Slump: [6 inch maximum].
- e. Air content: [4 to 6] percent.

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**Caution** - 5000 psi concrete is prone to hairline cracking.

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- 3. Exterior concrete exposed to freezing and thawing.
  - a. Compressive strength,  $f'_c$ : [5000 psi, at 28 days].
  - b. Maximum nominal aggregate size: [0.75 inch].
  - c. Maximum water/cement ratio: [0.34].
  - d. Slump: [4 inch maximum].
  - e. Air Content: [4 to 6] percent.
- 4. Interior concrete not exposed to freezing and thawing.
  - a. Compressive strength,  $f'_c$ : [3,000 psi at 28 days].
  - b. Maximum nominal aggregate size: [0.75 inch].
  - c. Maximum water/cement ratio: [0.44].
  - d. Slump: [4 inch maximum.]
  - e. Air content: [2 to 4] percent.
- 5. Interior concrete not requiring air entraining agent.
  - a. Compressive strength,  $f'_c$ : [3,000 psi, @ 28 days.]
  - b. Maximum nominal aggregate size: [0.75 in.]
  - c. Maximum water/cnt ratio: [0.34].
  - d. Slump: [4 inch maximum].
  - e. Air Content: [0 to 2] percent.

- D. In designing concrete mixes with fly ash and ASR aggregates consider effects on workability, set times, times for strength development and curing, and other characteristics. Make appropriate adjustments in construction activities, for example, times for removing forms or shoring.

- E. Use accelerating admixtures in cold weather only when submitted and approved as a constituent of the design mix prior to use. Use of admixtures will not relax cold weather placement requirements.
- F. Do not use calcium chloride as an admixture.
- G. Use set retarding admixtures during hot weather only when submitted and approved as a constituent of the design mix prior to use.
- H. Pre-approved Concrete Design Mixes (Ref: Amec Project No. 4-519-003279)  
These mix designs can be used as long as material properties remain constant. Submit source documentation and component analyses to verify compliance of the batching materials used for pre-approved mix design.

- LATM Mix No. 19 -- Exterior, 4000 psi concrete, 4" slump, 5% air, 20% fly ash (Proportions per CY):

|   |                       |
|---|-----------------------|
| Type I-II Cement :Gcc Rio Grande, Tijeras         | 656 lbs               |
| Class F, Fly Ash: Salt River Materials, 4-Corners | 164 lbs               |
| Water   | 295 lbs               |
| Washed Concrete Sand: El Guique Quarry            | 1079 lbs              |
| Sz#67 Coarse Aggregate: El Guique Quarry          | 1630 lbs              |
| Water Reducer: Mb poly heed 997                   | 41 oz <sup>(1)</sup>  |
| Air Entraining Agent: MB Micro Air,               | 8.2 oz <sup>(2)</sup> |

- LATM Mix No. 44 -- Exterior, 4000 psi concrete to be pumped, 6" slump, 5% air, 20% fly ash (Proportions per CY):

|   |                        |
|---|------------------------|
| Type I-II Cement :Gcc Rio Grande, Tijeras         | 656 lbs                |
| Class F, Fly Ash: Salt River Materials, 4-Corners | 164 lbs                |
| Water   | 295 lbs                |
| Washed Concrete Sand: El Guique Quarry            | 1079 lbs               |
| Sz#67 Coarse Aggregate: El Guique Quarry          | 1630 lbs               |
| Water Reducer, Mb poly heed 997                   | 57.4 oz <sup>(1)</sup> |
| Air Entraining Agent: MB Micro Air,               | 8.2 oz <sup>(2)</sup>  |

- LATM Mix No. 21 -- Interior, 4000 psi concrete, 4" slump, 3% air, 20% fly ash (Proportions per CY):

|   |                        |
|---|------------------------|
| Type I-II Cement :Gcc Rio Grande, Tijeras         | 520 lbs                |
| Class F, Fly Ash: Salt River Materials, 4-Corners | 130 lbs                |
| Water   | 280 lbs                |
| Washed Concrete Sand: El Guique Quarry            | 1243 lbs               |
| Sz#67 Coarse Aggregate: El Guique Quarry          | 1750 lbs               |
| Water Reducer: Mb poly heed 997                   | 25.7 oz <sup>(3)</sup> |
| Air Entraining Agent: MB Micro Air,               | 4.6 oz <sup>(4)</sup>  |

- LATM Mix No. 20 -- Interior, 3000 psi concrete, 4" slump, 3% air, 20% fly ash (Proportions per CY):

|   |         |
|---|---------|
| Type I-II Cement :Gcc Rio Grande, Tijeras | 417 lbs |
|---|---------|

|   |                        |
|---|------------------------|
| Class F, Fly Ash: Salt River Materials, 4-Corners | 104 lbs                |
| Water   | 268 lbs                |
| Washed Concrete Sand: El Guique Quarry            | 1378 lbs               |
| Sz#67 Coarse Aggregate: El Guique Quarry          | 1765 lbs               |
| Water Reducer, Mb poly heed 997                   | 20.8 oz <sup>(5)</sup> |
| Air Entraining Agent: MB Micro Air,               | 2.6 oz <sup>(6)</sup>  |

Note (1): Temperature and slump variation may require adjustment in dosage within the range of 24.6 fl oz / cy to 57.4 fl oz / cy

Note (2): Temperature and slump variation may require adjustment in dosage within the range of 1.025 fl oz / cy to 12.3 fl oz / cy

Note (3): Temperature and slump variation may require adjustment in dosage within the range of 19.5 fl oz / cy to 45.5 fl oz / cy

Note (4): Temperature and slump variation may require adjustment in dosage within the range of 0.8 fl oz / cy to 9.75 fl oz / cy

Note (5): Temperature and slump variation may require adjustment in dosage within the range of 15.6 fl oz / cy to 36.5 fl oz / cy

Note (6): Temperature and slump variation may require adjustment in dosage within the range of 0.65 fl oz / cy to 7.8 fl oz / cy

## PART 3 EXECUTION

### 3.1 GENERAL

- A. All concrete construction shall conform to applicable provision of ACI 301 unless otherwise specified herein.

### 3.2 EXAMINATION

- A. Verify lines, levels, and centers before proceeding with formwork. Ensure that dimensions agree with the Drawings.
- B. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.
- C. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.
- D. Do not use wood formwork more than three times for concrete surfaces to be exposed to view. Do not patch formwork.
- E. Verify that concrete cover for reinforcement conforms to the drawings and to Section 3.4.C herein.

### 3.3 FORMWORK

- A. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.
- B. Erect formwork, shoring and bracing to achieve design requirements and maintain tolerances in accordance with requirements of ACI 301 and ACI 347(or

more stringent design requirements). Camber structural slabs and beams in accordance with ACI 301. Contact surfaces of the formwork should be carefully installed to produce neat and symmetrical joint patterns, unless otherwise specified. Joints should be vertical or horizontal and, where possible, should be staggered to maintain structural continuity.

- C. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- D. Arrange and assemble formwork to permit dismantling, stripping and removal of remaining principal shores. Do not damage concrete during stripping.
- E. Align joints and make watertight. Keep form joints to a minimum.
- F. Obtain approval from the LANL Construction Inspector before framing openings (in structural members) which are not detailed on Drawings.
- G. Provide chamfer strips on external corners of beams, joists, columns, and walls.
- H. Apply form release agent prior to placement of reinforcing steel, anchoring devices, and embedded items.
- I. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.
- J. Do not apply form release agent where concrete surfaces receive special finishes or applied coverings which are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.
- K. Provide formed openings where required for items to be embedded in or passing through concrete work.
- L. Locate and set in place items which cast directly into concrete.
- M. Clean formed cavities of debris prior to placing concrete. Clean and remove foreign matter as erection proceeds.
- N. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- O. Install waterstops continuous without displacing reinforcement.
- P. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- Q. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.



- R. During cold weather, remove ice and snow from within forms. Do not use deicing salts or water to clean out forms. Use compressed air or other means to remove foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
- S. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and other imposed loads without excessive deflection or creep. Perform form removal in accordance with the recommendations of ACI 347.
- T. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- U. Store removed forms in manner to avoid any damage to form surfaces that will later be in contact with fresh concrete. Discard damaged forms.
- V. Do not use wood formwork more than three times for concrete surfaces to be exposed to view.
- W. After formwork removal, place construction or equipment loads on reinforced concrete only after cylinder break results indicate strengths meet specified requirements. Exceptions to this requirement must be approved in writing by the engineer of record.

### 3.4 REINFORCING PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position.
- B. Do not displace or damage vapor barrier.
- C. Maintain minimum concrete cover around reinforcing as follows:

| Item   | Minimum cover, in. |
|--|--------------------|
| <b><i>Slabs and Joists:</i></b>  |                    |
| Top and Bottom bars for dry conditions                                 |                    |
| No. 11 bars and smaller  | $\frac{3}{4}$      |
| No. 14 and 18 bars   | 1- $\frac{1}{2}$   |
| <b><i>Formed Concrete Surfaces Exposed to Earth/Water Weather:</i></b> |                    |
| No. 5 bars and smaller, W31 or D31 wire and smaller                    | 1- $\frac{1}{2}$   |
| No. 6 through No. 18 bars, W45 or D45 wire                             | 2                  |
| <b><i>Formed Beams and Columns:</i></b>                                |                    |
| Dry conditions –   |                    |
| Stirrups and ties  | 1- $\frac{1}{2}$   |
| Principal reinforcement  | 2                  |
| Exposed to earth, water, weather –                                     |                    |
| Stirrups and ties  | 2                  |

| Item  | Minimum cover, in.               |
|---|----------------------------------|
| Principal reinforcement   | 2-½                              |
| <b>Walls:</b><br>Dry Conditions –<br>No. 11 bars and smaller<br>No. 14 and 18 bars<br><br>Exposed to earth, water, weather –<br>All bars  | <br>¾<br>1-½<br><br>2            |
| <b>Footings and Base Slabs:</b><br>At formed surfaces and bottoms bearing on concrete workmat<br>At unformed surfaces and bottoms in contact with earth<br>Top of footings<br>Over top of piles | <br>2<br>3<br>Same as slabs<br>2 |

### 3.5 PREPARATION

- A. Prepare previously placed concrete by cleaning with steel brush, pressure washing, or other acceptable means to fully remove any laitance to assure that a “roughened” surface exists for bonding with the new concrete. Apply bonding agent in accordance with the manufacturer's recommendations.
- B. In locations where new concrete is to be dowelled to existing work, drill holes in existing concrete; insert steel dowels to the specified depth and pack solid with non-shrink grout that meets or exceeds the concrete minimum strength. Note: Non-shrink grout must be mixed, applied, and cured per the manufacturer's requirements.

### 3.6 PLACING CONCRETE

- A. Place concrete in accordance with ACI 301.
- B. Notify the LANL Construction Inspector a minimum of 24 hours prior to commencement of concreting operations.
- C. Ensure that reinforcement, inserts, embedded parts, formed joint fillers, joint devices, and formwork are not disturbed during concrete placement.
- D. Install vapor barrier under interior slabs on grade. Lap joints minimum 6 in. and seal watertight by sealant applied between overlapping edges and ends or taping edges and ends.
- E. Repair vapor barrier damaged during placement of concrete reinforcing.
- F. Install joint fillers, primer and sealant in accordance with manufacturer's instructions.
- G. Separate slabs on grade from vertical surfaces with ¼ in. thick joint filler.

- H. Extend joint filler from bottom of slab to within  $\frac{1}{4}$  in. of finished slab surface.
- I. Install joint devices in accordance with manufacturer's instructions.
- J. Place concrete continuously between predetermined expansion, control, and construction joints.
- K. Screed floors and slabs on grade level, maintaining surface flatness of maximum  $\frac{1}{4}$  in. in 10 ft.

### 3.7 CONCRETE FINISHING

- A. Provide formed concrete surfaces to be left exposed with smooth rubbed finish.
- B. Finish concrete floor surfaces in accordance with ACI 301.
  - 1. Finishes shall meet the requirements of ACI 301 section 5.3.4.2 and tolerances shall conform to ACI 117.
  - 2. Tolerances for floors, slabs, and floor finishes shall be confirmed by measuring in conformance with ACI 301 section 5.3.4.3.
- C. Wood float surfaces which will receive tile with full bed setting system.
- D. Steel trowel surfaces which will receive carpeting, resilient flooring, seamless flooring, or thin set tile.
- E. Steel trowel surfaces which are scheduled to be exposed.
- F. Provide a broom finish on exterior sidewalks and paving.
- G. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at  $\frac{1}{8}$  in. per foot, minimum.

### 3.8 CURING AND PROTECTION

- A. General.
  - 1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures and mechanical injury.
  - 2. Use all applicable practice and recommendations: for hot weather concrete application, from ACI 305R; for cold weather concrete applications from ACI 306R; for curing from ACI 308.
- B. Hot Weather Applications.

1. These practices (ACI 305R) shall be used when ambient daytime temperature at any time is 75 degrees F or more.
2. All applicable practices (ACI 305R) for production control and delivery including but not limited to temperature control, water content, slump, admixtures, and batching and mixing shall be employed.
3. Protection shall be provided from the sun and wind and all practice from ACI 305R Chapter 4 shall be followed in placing and curing.
4. Curing shall be by water curing methods per ACI 308 section 2.2.
5. Alternate means of curing will be allowed only if pre-approved by the LANL Contracting Officer. If approved, liquid membrane curing must strictly follow manufacturer's recommendations for application including volume of coverage per square foot. Application shall follow ACI 308 section 2.3.3.
6. Protection and curing of concrete shall conform to provisions of ACI 301 section 5.3.6.

C. Cold Weather Applications.

1. Use all applicable provision from ACI 306R and meet the requirements of ACI 306.1. Comply with recommended concrete temperatures "as mixed" and "as placed and maintained" from Table 3.1 of ACI 306.R. Comply with Table 7.6.1.1 of ACI 301 for temperatures of delivered concrete.
2. Curing shall be in accordance with ACI 306R sections 8.2 and 8.3, ACI 306.1 sections 3.3 and 3.4, ACI 308 section 2.4, and other applicable provisions.

### 3.9 CONTROL/CONTRACTION JOINTS

- A. While the concrete is still plastic (i.e., within several hours after placement), provide joints in slabs at no more than 10 feet on center in each direction. The depth of each joint will be at least one-quarter of the slab thickness, but not less than one inch.

### 3.10 FIELD QUALITY CONTROL

- A. PROVIDE A CERTIFIED TESTING AGENCY TO PERFORM FIELD TESTING IN ACCORDANCE WITH ACI 301. Testing laboratory certification may be obtained through AASHTO or another nationally recognized accreditation service as allowed by ASTM C-1077. Submit current certifications of testing agencies and personnel performing testing services for approval by the LANL Building Official, or designee, in accordance with the provisions of the IBC.
1. Testing agencies for performing testing services on concrete materials shall meet the requirements of ASTM 1077.

2. Field testing of concrete shall be performed by an ACI Certified Concrete Field Testing Technician – Grade I.
  3. Laboratory testing of concrete shall be done by ACI-Certified concrete laboratory technician-grade 1 or equivalent per ASTM C-1077
- B. Submit proposed mix design of each class of concrete to the LANL Construction Inspector for approval prior to commencement of work.
- C. Inform the LANL Construction Inspector 48 hours in advance of field testing to allow for witnessing of testing.

\*\*\*\*\*

The Structural Engineer shall determine the frequency and type of field and laboratory testing. The batch plant that supplies concrete to LANL currently produces concrete with a standard deviation of 700 psi for 4000 psi air entrained concrete.

\*\*\*\*\*

- D. The Testing Agency shall perform the following tests and collect strength cylinders on one batch in every 50 cu. yds. of concrete placed or once a day when less than 50 cu. yds. is placed. Samples for Acceptance Testing are to be taken at the discharge from the transit mixer, except when using concrete pumps or conveyors to transport concrete to its final placement location. When pumps or conveyors are used, the samples for acceptance tests shall be taken at the end of the pipe or last conveyor belt. Note: The tests below shall always be performed whenever concrete test specimens are taken. All concrete is to be tested.
1. Sample concrete in accordance with ASTM C-172.
  2. Record temperature of concrete in accordance with ASTM C 1064.
  3. Perform slump test in accordance with ASTM C 143.
  4. Perform air content test in accordance with ASTM C 231, pressure method.
  5. [Perform density testing in accordance with ASTM C-138.]
  6. Take 4 concrete strength test cylinders in accordance with ASTM C 31.
- E. The Testing Agency shall test the strength test cylinders in accordance with ASTM C 39 at 7 days and 28 days.
- F. Coordinate the sequencing of concrete construction to schedule LANL concrete specialty inspection per the requirements of Chapter 17 of the IBC. Provide 48 hour notification to schedule specialty inspectors.

\*\*\*\*\*  
Mixes incorporating fly ash cement replacement typically show higher long-term strength (90 days) and an initial slower strength gain than for regular mixes without fly ash. Fly ash mixes typically show that the compressive strength at 28 days with Class F fly ash cement replacement is between 80% and 95% of the strength without replacement.  
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### 3.11 CONCRETE ACCEPTANCE CRITERIA

#### A. Fresh Concrete

1. Temperature - Less than 90 degrees F.
2. Slump - per Section 2.7.
3. Air content - per Section 2.7.
4. Drum revolution counter - 100 to 300 revolutions within 1-1/2 hours after initial mixing.

#### B. Strength

1. Concrete strength is satisfactory if the average of all sets of 3 consecutive strength test results equal or exceed the specified 28 day strength  $f'_c$  and no individual strength test result falls below the specified 28 day strength  $f'_c$  by more than 500 psi.

#### C. Appearance

1. Free from honeycombs, embedded debris, and dimensional variance beyond ACI-301 and ACI-301 references.

#### D. Construction requirements

1. Conforming to required lines, details, dimensions and tolerances specified for construction.

### 3.12 DEFECTIVE CONCRETE

- A. Defective concrete is concrete not conforming to acceptance criteria in Section 3.11.
- B. Do not accept or place defective concrete that is not in conformance with acceptance criteria. Return the fresh concrete to the supplier.
- C. Replace defective concrete not meeting strength criteria, at Contractor's expense. The Contractor may, at its expense, evaluate the concrete's in-place strength by testing 3 core samples for each strength test where LANL cured

cylinders were more than 500 psi below  $f'_c$  in accordance with ACI 301 and ASTM C42. Fill core holes in accordance with ACI 301.

- D. Replace defective concrete not meeting appearance criteria, at Contractor's expense. The Contract Administrator may allow repair of defective concrete at Contractor's expense.
- E. Replace concrete not in conformance with details, tolerances, and other construction requirements at Contractor's expense.

#### END OF SECTION

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Do not delete the following reference information:

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#### FOR LANL USE ONLY

This project specification is based on LANL Master Specification 03 3001 Rev. 1, dated June 28, 2006.